Rapid Modelling of the Pandemic: The COVID-19 Contact-Tracing Model

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epic
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https://github.com/ScottishCovidResponse/Contact-Tracing-Model

The SCRC & RAMP

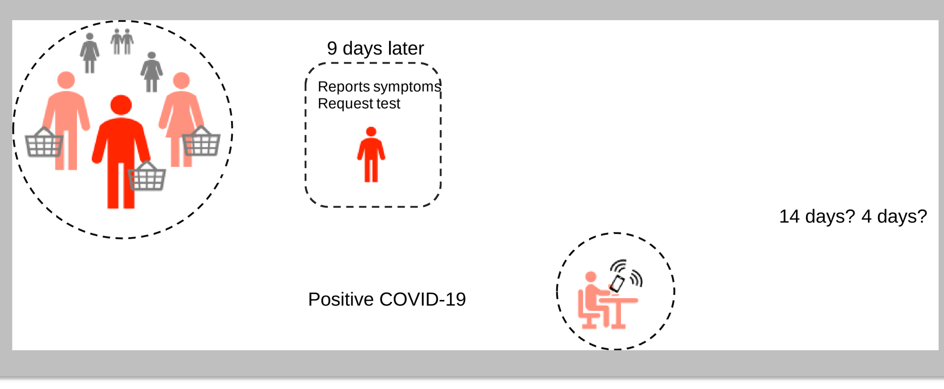
The Scottish COVID-19 Response Consortium (SCRC) was originally formed in 2020 by the Boyd Orr Centre for Population and Ecosystem Health (University of Glasgow), Biomathematics and Statistics Scotland (BIOSS), and the Scottish Government's Centre of Expertise on Animal Disease Outbreaks (EPIC). We responded to a call by the Royal Society to develop epidemiological models of COVID-19 spread (Rapid Assistance In Modelling The Pandemic: RAMP)

From Foot-and-Mouth disease to Covid-19

Modelling animal disease outbreaks shares many approaches and challenges with the modelling of COVID-19. We adapted our existing large-scale foot-and-mouth disease (FMD) model, originally used to explore flexible movement standstill scenarios, to assess different potential medium- and long-term strategies for controlling the COVID-19 epidemic in Scotland and the UK.

Contact-Tracing

The isolation of symptomatic / positive cases and tracing of contacts has been used as an early and effective COVID-19 containment measure in many countries. To maintain control of infection, there is a need to understand what combination of measures—including manual and novel digital tracing approaches —might be required to reduce transmission whilst also minimising disruption to populations.



Key questions

What are the optimal contact tracing protocols?

- Benefits of blanket vs tailored actions and advice for alertees?
  - how long should isolation be? Should it depend on the time of contact?
  - how should testing be targeted/optimally deployed?
- **What are the behavioural changes that most improve impacts?**
  - Rapid testing of symptomatics; Increase uptake of app vs. compliance with advice

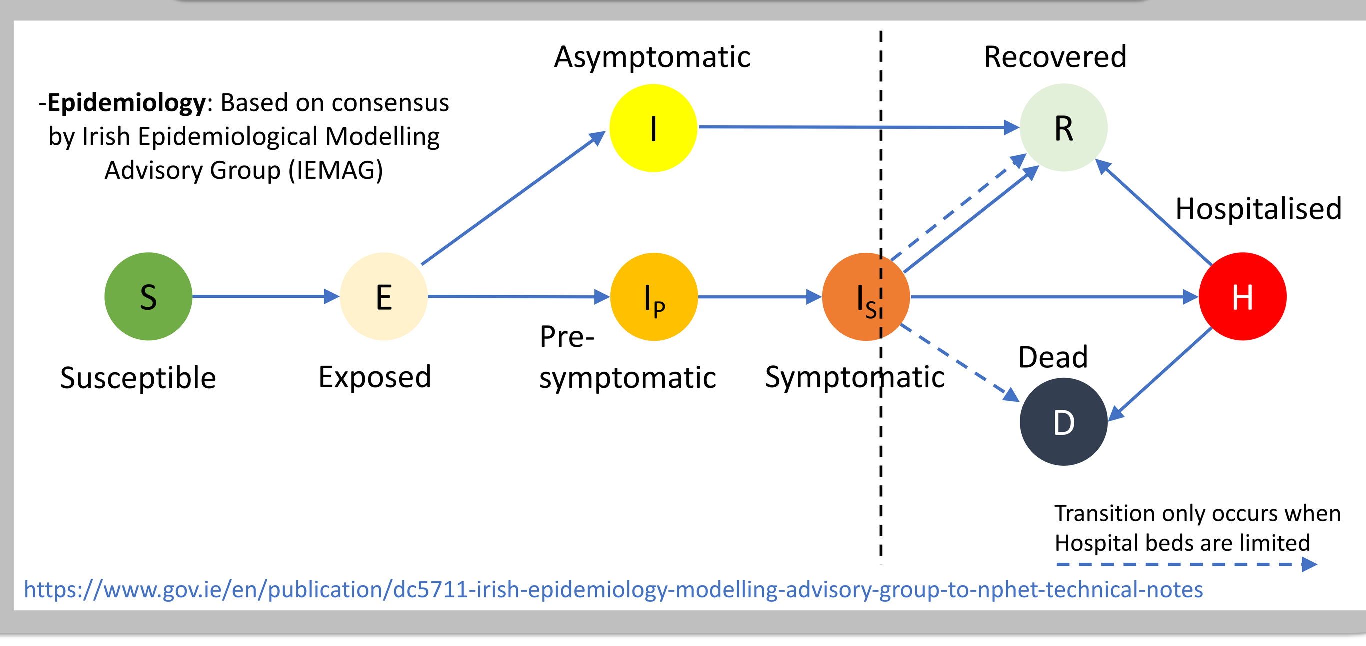
Practical implications

- Optimal protocol can be tailored to current non-pharmaceutical interventions (NPIs), e.g. closing / reopening of schools / offices etc.

Model features

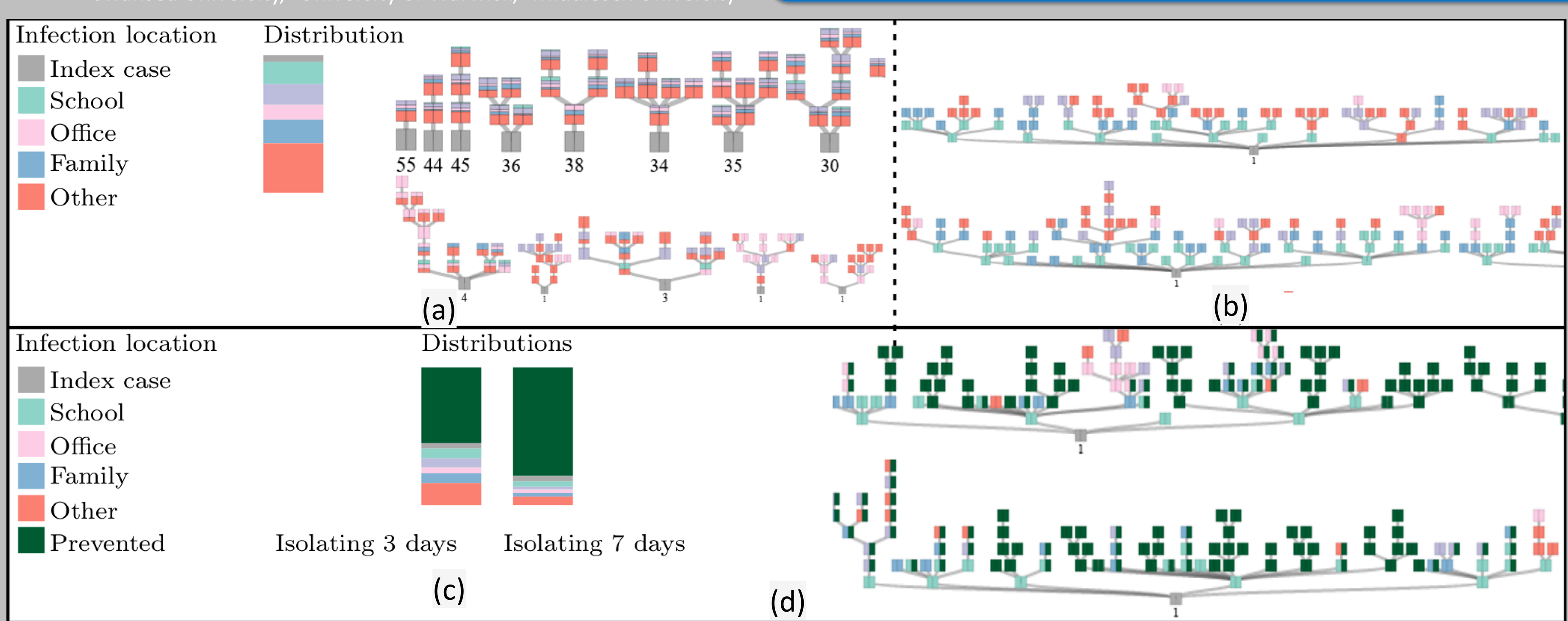
Language	Java
Spatial scale	No explicit spatial scale but a form of 'location' is retained
Model type	Individual-based stochastic network model; Model uses compartmental structure for disease progression • Age-structured individuals • Weighted contacts
Features	Flexible contact tracing scenarios
Mode	Forward simulation, user-defined timesteps

Disease progression



Comparing policy scenarios: an example

Visual Analytics of Contact Tracing Policy Simulations: M.Sondag[1] , C. Turkay[2] , K. Xu[3] and D. Archambault[1]
[1] Swansea University, [2]University of Warwick, [3]Middlesex University



Visualisation of impact of different policy scenarios on infection / transmission chains: index cases of infections are depicted as grey nodes. When comparing policy scenarios (c-d), each node is divided into two halfs, the left half representing one scenario, the right half representing another scenario (d). The more green a tree becomes, the more infections are prevented by a policy. (a) Overall, short infection chains do not originate from infections at school. (b) School infections cause most of the large infection chains (c) Comparing policy settings by increasing isolation time from 3 days (Figure (c), left bar charts) to 7 days (Figure (c), right bar) significantly reduces transmission (green bar). Increasing isolation time is particularly successful in breaking up long transmission chains by preventing onwards transmission (Figure (d)).

Example of policy comparison on individual transmission chains (Fig. left): Transmissions at school cause most of the large infections chains in our model. Here, we investigate the effect of different policy settings on school transmissions by comparing two isolation policy settings: (i) a policy whereupon becoming symptomatic, the person and all their contacts from the last 3 days isolate for 3 days, and (ii) a policy where they isolate for 7 days instead. This extra isolation time has a large impact overall in preventing infections, including in school settings (Figure (d)). Note that for some infections chains in (Figure (d)), infection remains the same between policies and transmission is not prevented through longer isolation time. Closer inspection revealed that the index cases for these infection chains were asymptomatic, and thus did not go into isolation until one of their contacts became symptomatic.

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